Unit 2

Part 3

Regulation

AP Biology

Mrs. Petrov

Disruptions

- All biological ***systems*** are affected by disruptions.
  - Organism dehydration
  - Immune responses to pathogens
  - Invasive species
  - Hurricanes, Floods, Volcanoes

Types of Homeostatic Responses

- Behavioral
  - Nocturnal activity
  - Hibernation
- Physiological
  - Immune responses
  - Shivering
  - Sweating
  - Phototropism

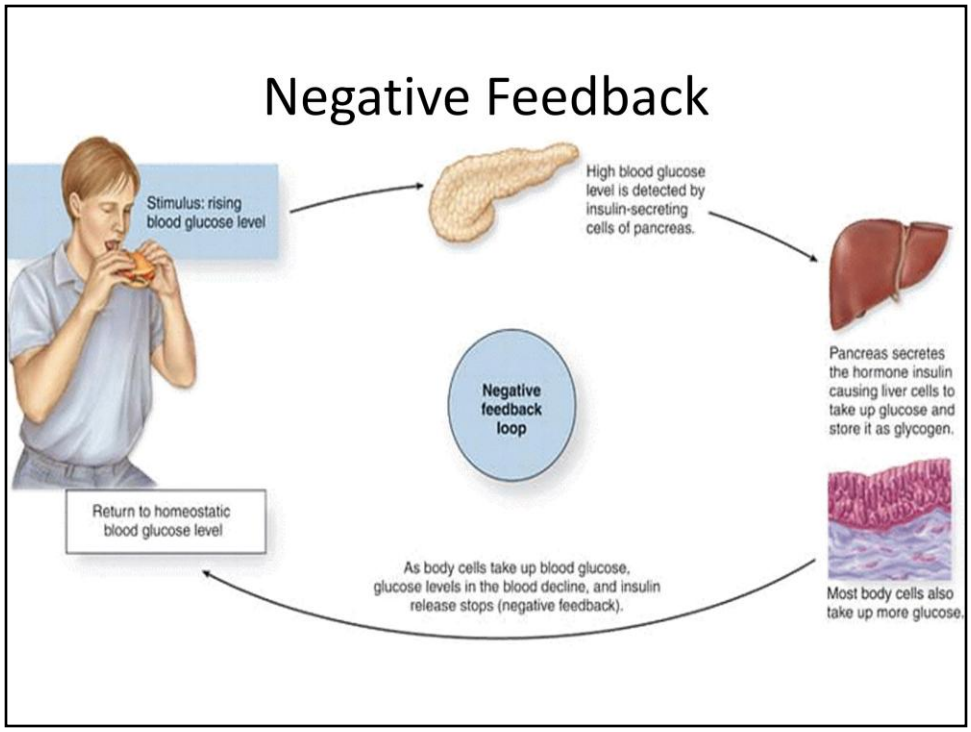
Common Ancestry

- Internal homeostatic mechanisms reflect both common ancestry and divergence due to adaptation in different environments.
  - Respiratory systems on land & in water
  - Digestive mechanisms in animals
  - Excretory systems
  - Osmoregulation
  - Immune systems

Feedback Mechanisms

- Organisms use feedback mechanisms to maintain their internal environments and respond to environmental changes.

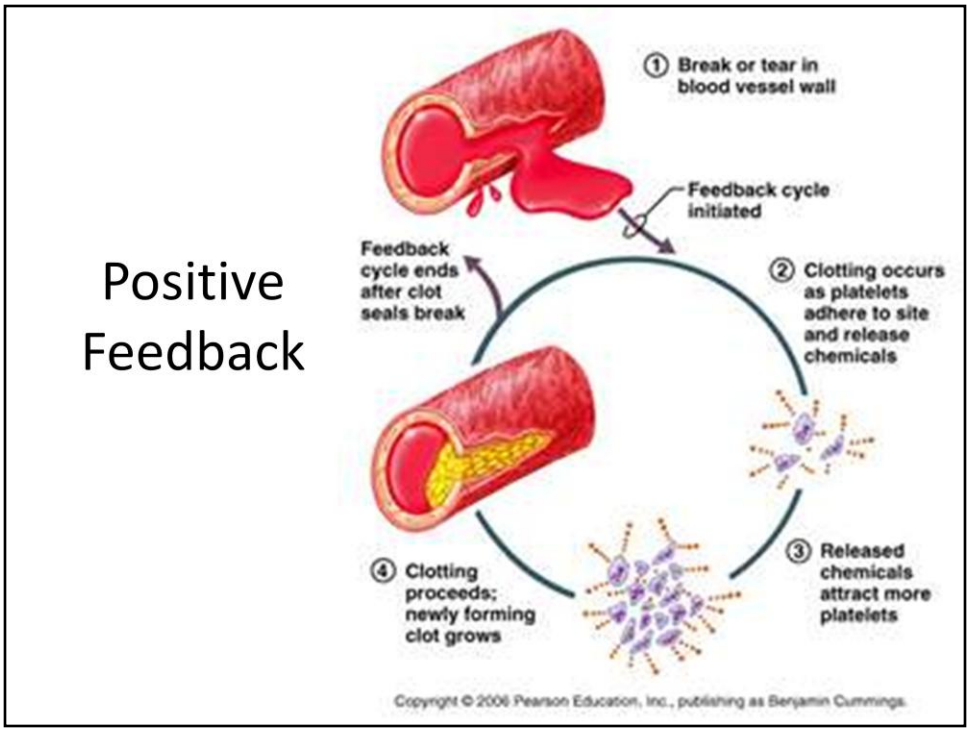
- Negative Feedback
- Positive Feedback



What disease is associated with this feedback system?

Where in the “loop” can the disease cause problems?

Positive Feedback



What disease is associated with this feedback loop?

Where in the loop can the disease cause problems?

Defenses

- Plants & Animals have a variety of chemical defenses against infections that would otherwise affect homeostasis
- Plants, invertebrates & vertebrates have many non-specific immune responses
- Vertebrates also use specific immune responses

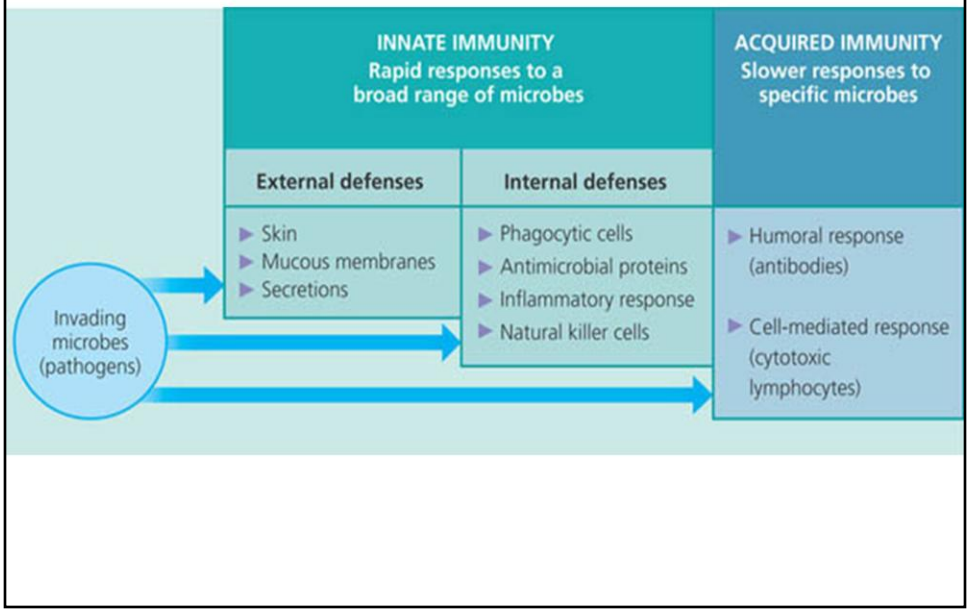
What is a non-specific immune response?

Plants: 39.5

Animals: 43.1

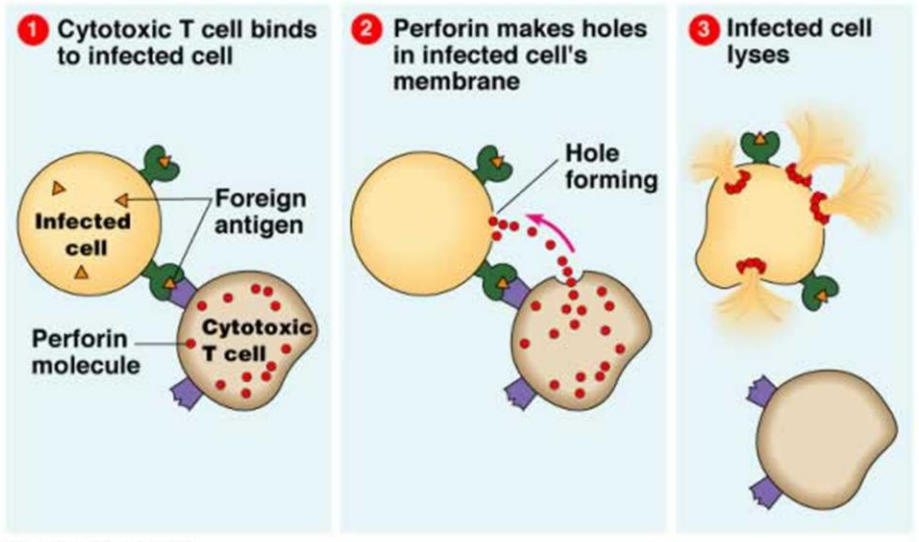
What is a specific response?

Specific Responses: 43.2 - 43.3


INNATE IMMUNITY
Rapid responses to a broad range of microbes
ACQUIRED IMMUNITY
Slower responses to specific microbes
External defenses
Internal defenses
Skin
Mucous membranes
Secretions
Phagocytic cells
Antimicrobial proteins
Inflammatory response
Natural killer cells
Humoral response (antibodies)
Cell-mediated response (cytotoxic lymphocytes)
Invading microbes (pathogens)

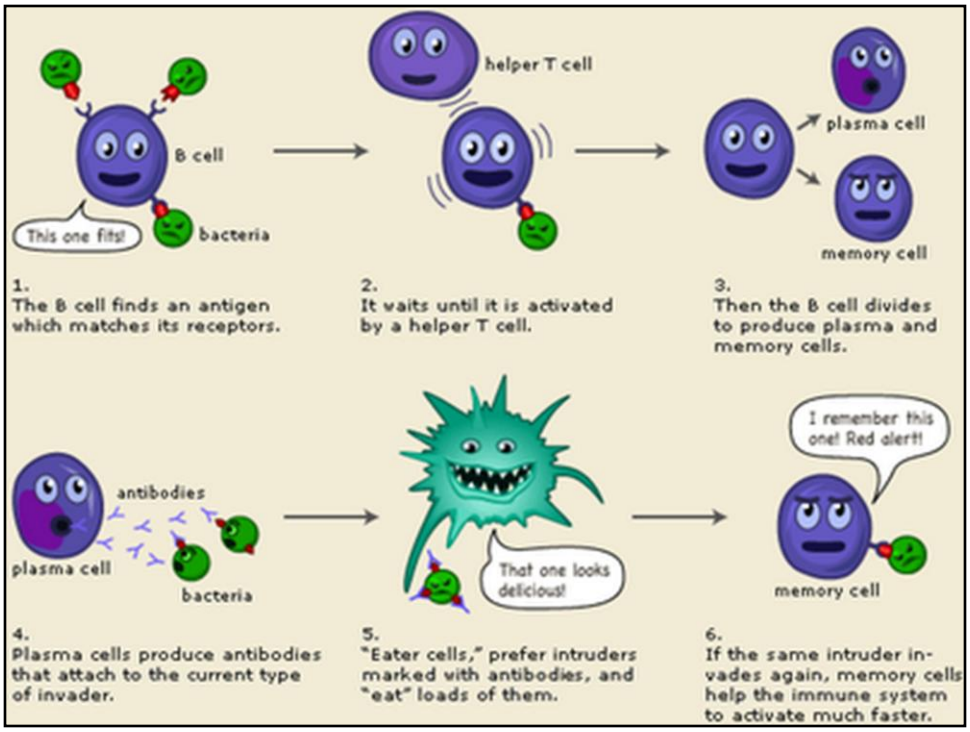
2 Types of Specific Immunity

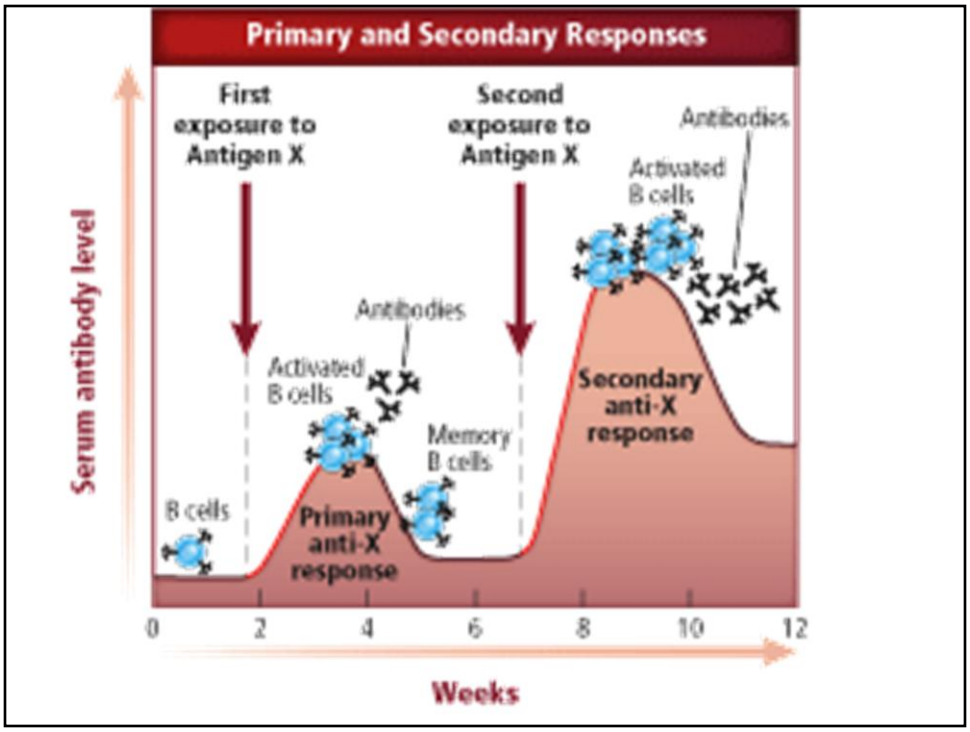
- 1. Cell-Mediated Response
  - Cytotoxic T cells (White Blood Cell type)
  - Target intracellular pathogens
  - Signaled by antigens (anything that acts as a signal to “non-self” by immune cells)


1 Cytotoxic T cell binds to infected cell
Infected cell
Foreign antigen
Perforin molecule
Cytotoxic T cell
2 Perforin makes holes in infected cell's membrane
Hole forming
3 Infected cell lyses
©Addison Wesley Longman, Inc.

2 Types of Specific Immunity

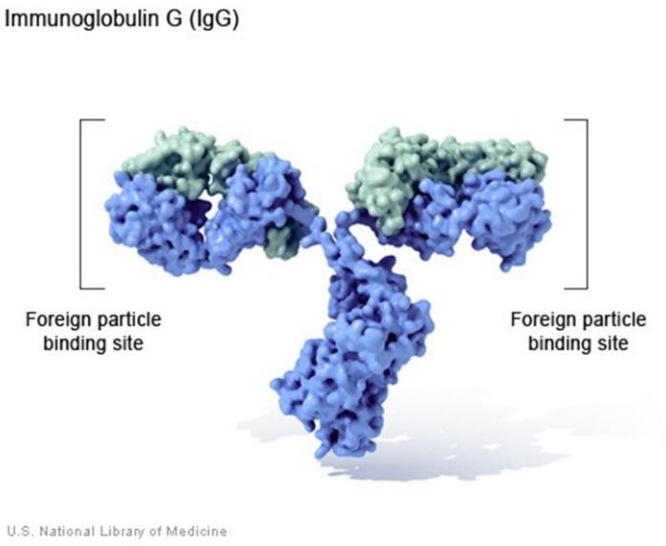
- 2. Humoral Response
  - B cells (White Blood Cell type)
  - Produce Antibodies & memory B cells
  - Antibodies specific to each different antigen!
    - Protein markers (Immunoglobulins)
  - Second exposure to same antigen results in a more rapid and enhanced immune response because memory B cells are ready!


B cell
This one fits!
bacteria
helper T cell
plasma cell
memory cell
1.
The B cell finds an antigen which matches its receptors.
2.
It waits until it is activated by a helper T cell.
3.
Then the B cell divides to produce plasma and memory cells.
antibodies
plasma cell
bacteria
That one looks delicious!
I remember this one! Red alert!
memory cell
4.
Plasma cells produce antibodies that attach to the current type of invader.
5.
"Eater cells," prefer intruders marked with antibodies, and "eat" loads of them.
6.
If the same intruder invades again, memory cells help the immune system to activate much faster.



Explain the graph

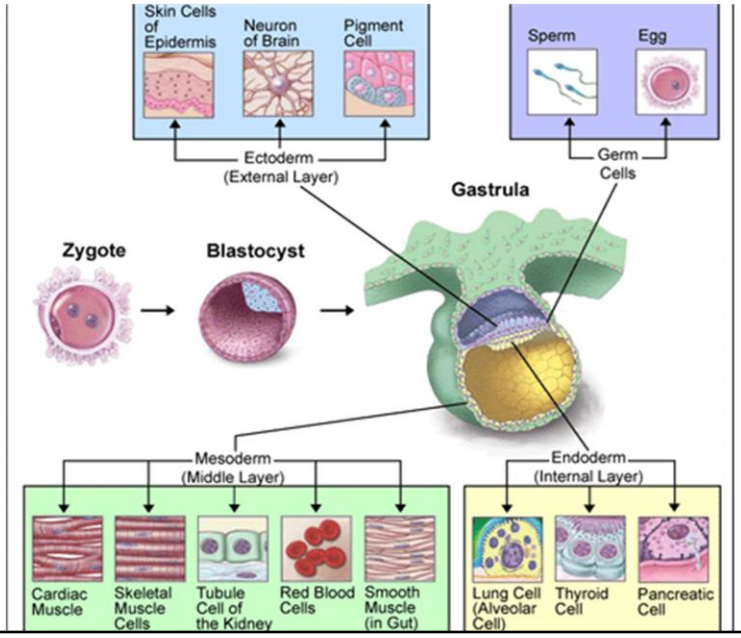
- Antibodies are proteins, hence the vast number of possible types.



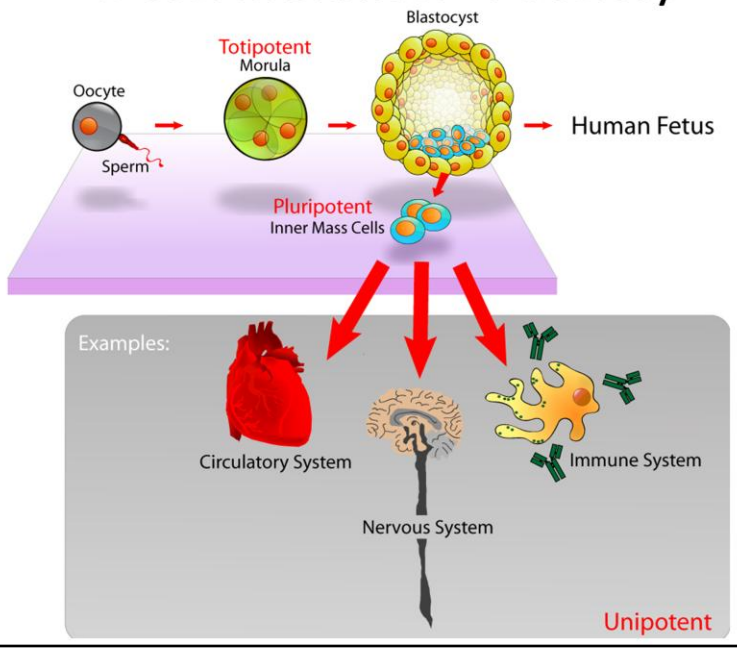
Regulation Mechanisms

- Timing & coordination of responses are **regulated** by various mechanisms.

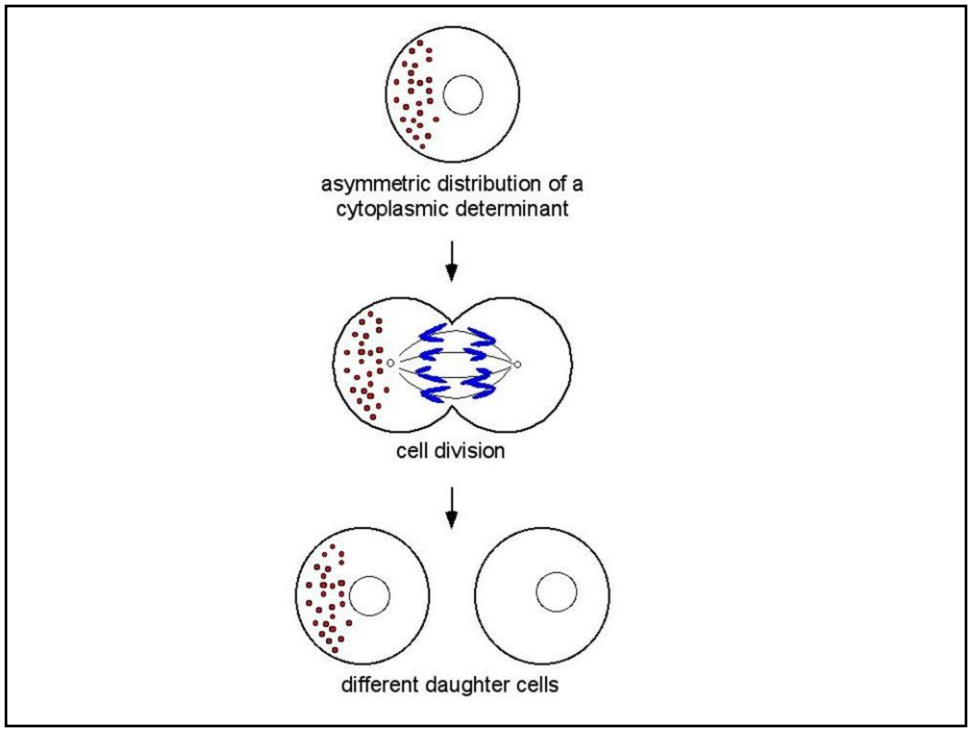
1. Organism Development



Determination-"Potency"

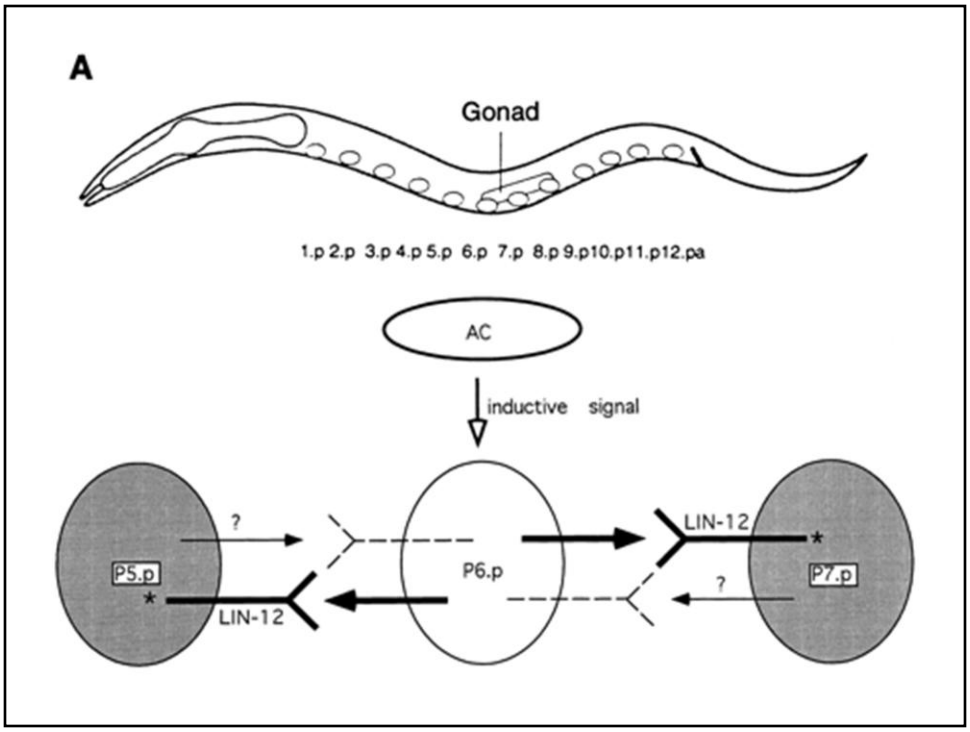


- ALL cells (except immune) have a complete set of instructions (DNA).
- Why do they end up looking ***different***???
  - Blood cells Nerve cells Skin cells
- The DNA is ***expressed differentially!***
- Regulators:
  Transcription Factors Inductive signals

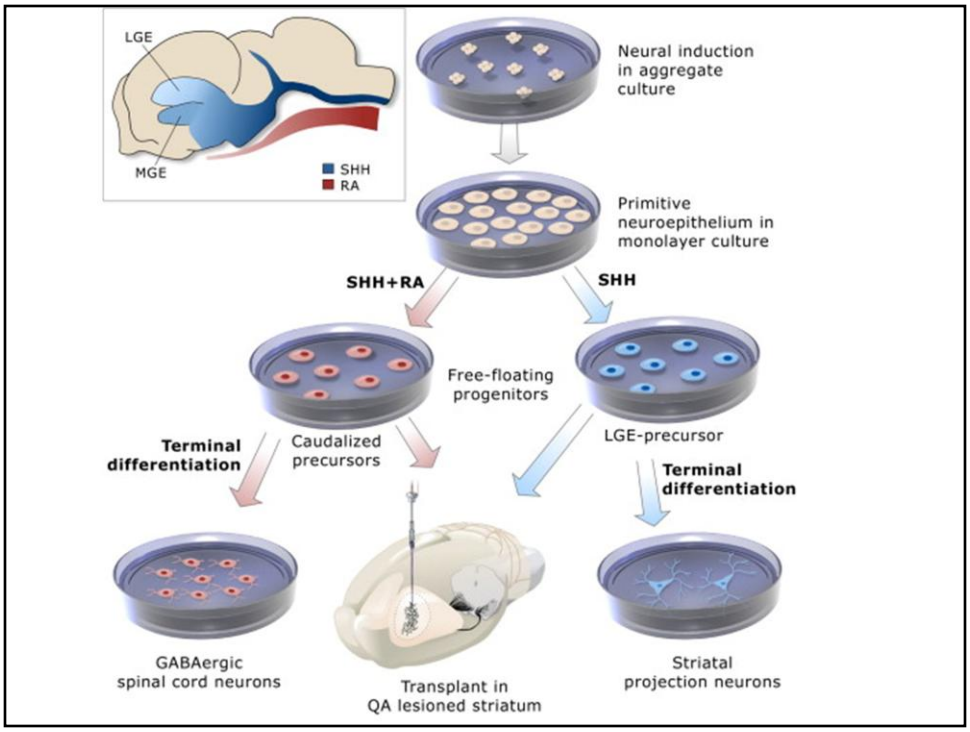


Both new cells have the same DNA, but the other molecular substances are distributed differently.

What is the result of this?



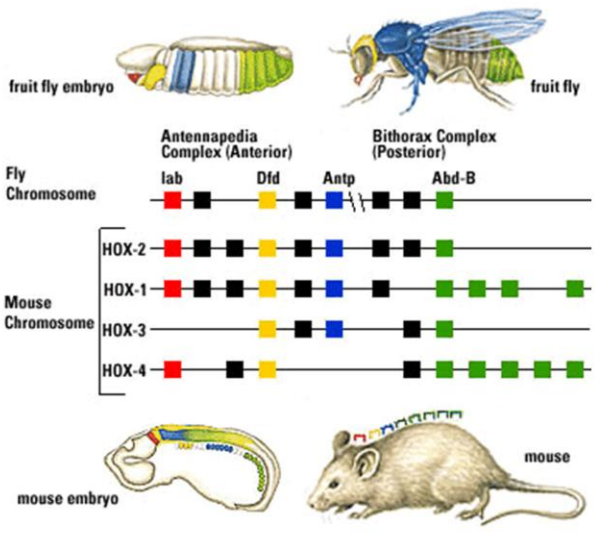
Each cell can send its unique molecular signals to other cells, and also receive signals from other cells.



Stem cells exposed to different chemicals will develop differently.

Homeotic (HOX) Genes

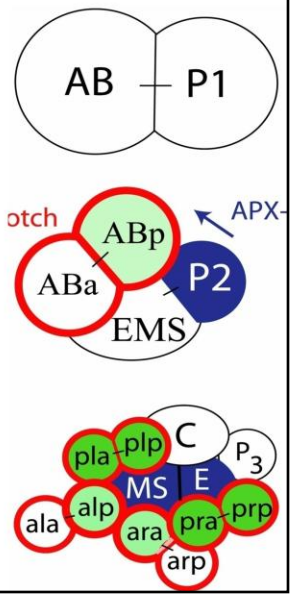
- Developmental Patterns & Sequences
- Body Plan
- Small mutations are **LETHAL**
- Common to most animals.



How is the theory of evolution/common descent supported by this data?

Induction & Coordination of Events

- P_1 division asymmetric; produces EMS and P_2 that express distinct sets of proteins.
- AB division symmetric; Produces ABa and ABp; initially equivalent.
- However, the posterior displacement of ABp puts it in contact with the P_2 cell; thus some genes are activated in ABp, but ***not*** in ABa.
- Likewise, some genes expressed in ABa due to contact with EMS.



miRNA

- MicroRNAs extremely important during development.
- Embryonic stem cells that do not form miRNAs fail to differentiate in vitro and in vivo.
- Regulate gene expression by either **degrading** mRNAs or **blocking** their translation.

Why would **degrading/blocking** protein production be important during development?

Mandatory Death!

- **Apoptosis**: Programmed cell death

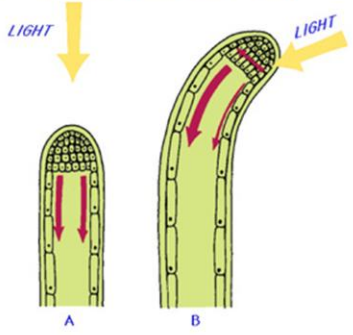
- Normal development of the fingers and toes depends on death of the cells forming webs between them.
- In carnations, ethylene produced from the pollinated stigma is translocated, via the style and ovary, to the petals. Here it up-regulates ethylene biosynthetic genes and induces the production of ethylene in the petals. This ultimately leads to death of the flowers.

2. Physiological Responses

- Plants
- Interactions between environmental stimuli and internal molecular signals.
- **Phototropism**: response to light
- **Photoperiodism**: response to change in length of night: flowering of short/long-day plants
- Based on **plant hormones** triggered by light/water/gravity/attack by predators

Phototropism in Shoots

Light stimulates the movement of Auxin away from the light source. The increased supply of Auxin to cells opposite the light source causes them to elongate more than the cells on the same side as the light source.



Photoperiodism

- Amount of **darkness** triggers photoreceptor cells, which trigger flowering.
- Long day plants- less darkness (longer days) triggers flowering.
  - Carnations, Oats, Clover
- Short day plants – more darkness (shorter days) trigger flowering.
  - Strawberry, Poinsettia, Coffee

Develop a plan to test the previous two examples of plant responses.

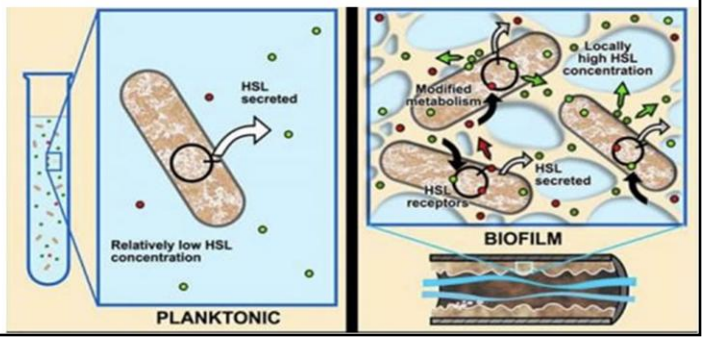
Address how they can be tested as being important to natural selection.

2. Physiological Responses

- Animals
- Internal & external signals regulate a variety of physiological responses that synchronize with environmental cycles & cues.
  - Circadian rhythms, Jet lag, aggressiveness in males during reproductive cycles

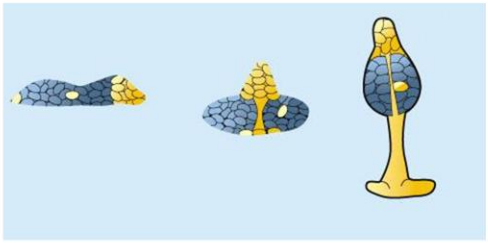
2. Physiological Responses

- Bacteria
- **Quorum** sensing to coordinate certain behaviors based on the local density of the bacterial population



2. Physiological Responses

- Fungi
- Fruiting body formation in response to nutrients available.



Behaviors

- Timing & coordination of behavior are regulated by various mechanisms and are important in natural selection.

Provide 3 examples that justify the claim above.

Inherited vs. Learned

- Learned behavior – occurs through interactions with the environment and other organisms
  - Prey selection -Community Ranks
- Innate behavior – inherited
  - Crying baby
  - Animal courtship (birds, insects)

Coyote vs. Porcupine…OUCH!!!

Hanging Flies

Males give a nuptial gift prior to mating.

In "primitive" species, the nuptial gift is an item of **prey**.

In more "advanced" species, males wrap the prey in silk.

In other species, males offer just a ball of silk.

Evolution, 1/e Figure 17.4

Using the previous example with hanging flies…

Predict the various female responses to each “gift”.

Analyze the males’ strategies in each scenario as related to natural selection.

Are these innate or learned behaviors? Justify your response.

Cooperativity

- Cooperation within or between populations contributes to the survival of the populations.

Provide 4 examples of cooperativity among organisms.